

Fuzzy Math in Household Finance:
A Practical Guide

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A new body of research at the intersection of economics and psychology is asking questions about how people make financial decisions and coming up with some surprising answers. In contrast to the views held by traditional economic theory, the new research is finding that individuals often have self-control problems, overly optimistic expectations, and heuristics that do not square well with traditional concepts of rationality. These “behavioral” aspects of financial decision-making have been shown to have important real-world effects.

Our research sets out in a new direction by asking how people’s *intuitive assessments about complex mathematical problems* affect their decisions.

Here are two examples:

- a. How much would you end up with if you invested \$10,000 and left it in a mutual fund that earns a 7% average annual return for 30 years?
- b. If you were borrowing \$10,000 to buy a car and had quotes from two lenders, one for an APR of 8% and one for 48 monthly payments of \$299, which would you prefer?

While many people use calculators or other aids to good effect when making borrowing and investment decisions, many others do not. Instead they rely on their best “educated guess.” In principle this is not a problem, as long as a substantial share of people are close to correct, or if people’s mistakes are not biased in particular directions.

But our research suggests that when faced with scenarios like the ones above, people don’t just make *mistakes*: they are *biased* toward mistakes that lead to borrowing too much and saving too little.

Take the first example: the “future value” of the initial \$10,000 investment described above ends up being roughly \$76,000. But most people estimate a future value that is far below that. In general, individuals tend to systematically underestimate the returns to saving and investing when the opportunities are relatively long-term and/or high yielding. They underestimate returns because they underestimate how quickly interest *compounds*.

Take the second example: the second loan offer described above, with the \$299 monthly payment, implies an APR of about 20%. But most people guess that the APR on that offer is much lower. In general, most people tend to systematically underestimate the interest rate when they try to infer it from information on (“low”) monthly payments.

People underestimate borrowing costs because they fail to recognize that they don't get to borrow the full loan amount for the full maturity: they have to pay principal back as they go along. This problem is a mirror image of underestimating compound interest.

Both biases – underestimating compound returns, and underestimating loan interest rates – appear to stem from a single cognitive bias in how most people intuit the mathematics of borrowing and savings. The link is exponentiation, which features prominently in the tradeoffs inherent to borrowing and savings decisions. Exponentiation turns out to be very difficult for the human mind to grasp. Decades of research in cognitive psychology shows the nearly everyone dramatically underestimates how quickly exponential series grow or decline.

Our research links this *exponential growth bias* to economics by showing that biased underestimates of exponential growth produce *present-biased perceptions* of financial tradeoffs that favor borrowing and discourage saving.

Exponential growth bias is easy to measure by asking people a math question about compounded growth (e.g., population, pollution), or by asking financial questions like our examples above. Our research shows that a metric of exponential growth bias helps predict household financial decisions and condition above and beyond standard economic variables (such as income, education, age, impatience, and risk tolerance). The findings suggest that consumers who are more prone to “fuzzy math” borrow more, save less, and tilt their portfolios toward more expensive loan products and less remunerative investments. Their decisions are distorted by their incorrect and biased perceptions of financial tradeoffs.

The key questions, of course, are “How does this play out in the market?” and “What role is there for public policy?” While we do not yet have conclusive answers, we have some informed speculation based on evidence from our studies thus far.

Our work suggests that in credit markets, effective enforcement of Truth-in-Lending law is critical. Lenders who comply with Truth-in-Lending are much less likely to emphasize “low monthly payments” and obscure loan APRs in order to take advantage of exponential growth bias. More-biased consumers taking loans made by compliant lenders do not pay higher interest rates than less-biased consumers.

But some lenders face relatively lax enforcement of APR disclosure requirements. And when more-biased consumers borrow from these noncompliant lenders they do pay higher interest rates.

On the saving side, our research provides a simple explanation for consumer “undersaving”. This is an issue of growing concern given the low and falling savings rate in the United States, and the expanding array of savings and investment decisions that are put into the hands of consumers with the increasing importance of defined-contribution pensions.

So our work points to a new source of problems in consumer financial decision making.

It also points to potential solutions for improving financial decision making. Marketing that highlights future values should counteract biased underestimates of the returns to long-run, high-yield investing. Expert advice seems to mitigate or even eliminate the effects of bias altogether. Decision aids (such as simple financial calculators) have been shown to help in laboratory settings. Simple heuristics— such as the “rule of 72” for estimating compounded growth, and its analog for estimating an APR from simple interest— are easy to teach, and can dramatically improve decision making. And mandated APR disclosure also appears to help— when it is effectively enforced.

The exciting thing is that each of these methods for “treating” fuzzy math has the potential to be cost-effective. Each of the treatment approaches outlined above has a sector with strong incentives to administer it effectively. Regulators concerned with consumer protection should, and to some extent already are, experimenting with content and enforcement to make mandated credit disclosures more effective. Brokerage funds, retirement plan administrators, and mutual fund retailers have strong incentives to market savings and investment products effectively, and to equip consumers with simple rules and aids that help convert discretionary borrowers to savers. Nonprofits might find it more effective to switch gears from trying to improve financial literacy through *education*—which takes lots of money and time, and suffers from low takeup rates— to target marketing financial *survival skills*. It should be relatively easy to target market those who are prone to fuzzy math: exponential growth bias is easy to measure itself, and also highly correlated with widely available demographic variables.

Another key point is that there is a strong normative basis for treating fuzzy math. When people get the mathematics underlying financial decision making wrong, we’d clearly likely to help them get it right. In contrast dealing with the other leading explanations for poor financial decision making-- self-control problems and biased expectations-- is a thornier proposition. How do we determine who has a self-control problem? And if they have one, how do we know what they really want? How do we determine who is overly optimistic or overly pessimistic? Perhaps they simply know something we don’t.

In all we emphasize that our findings and prescriptions are more conjecture than fact at this point. It is important to be circumspect about our theory, findings, and prescriptions, all of which require further testing in real-world settings.

In particular we are concerned that policymakers and consumer “advocates” will seize on fuzzy math as yet another consumer bias that motivates restricting access to expensive consumer loan products. This is misguided in our view.

At this point most prescriptions (including our own) are far ahead of the evidence. A more reasonable approach is to hold off on major policy changes and invest in the research and development of financial decision making. We should systematically study whether and how different disclosure formats, product presentations, new products, decision aids, and heuristics actually improve real-world decision making.

Suggestions for Further Reading

- Campbell, John Y. (2006). "Household Finance." *Journal of Finance* LXI(4): 1553-1604. August.
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- Eisenstein, Eric and Stephen Hoch (2005). "Intuitive Compounding: Framing, Temporal Perspective, and Expertise." Working Paper. December.
- Stango, Victor and Jonathan Zinman (2007). "Fuzzy Math and Household Finance: Theory and Evidence." Working Paper. November.
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